TREE PLANTING IN THE ALLEGHENY SECTION

A survey of current planting practices by the Silviculture Committee of the Allegheny Section, Society of American Foresters

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PREFACE

TREE planting involves many considerations — site classification, selection of species, planting practices, and protection from fire, insects, and diseases. The information about many of these aspects of planting is scattered and fragmentary.

To bring this information together in forms that will be useful to the forester and landowner, two professional groups have been working for some time. A committee of the Northeastern Forest Soils Conference has gathered information to prepare a tentative planting-site classification for the Northeast. And the Silviculture Committee of the Allegheny Section of the Society of American Foresters has made a survey of current tree-planting practices in its territory.

The Northeastern Forest Experiment Station of the U. S. Forest Service is publishing the reports of both committees. This is the second of the two reports. The first, titled "Planting Sites in the Northeast," has been published as No. 157 in the Station's series of Station Papers.

This publication is the Allegheny Section's report on current tree-planting practices in the region. Many people contributed to this project. More than 50 foresters, representing federal and state forestry organizations, universities, and private agencies throughout the 5-state territory of the Allegheny Section helped in carrying out the survey of planting practices upon which this report is based.

The Silviculture Committee of the Allegheny Section acknowledges its thanks to these people. Special thanks are given to William E. Waters and Robert W. Brandt of the Northeastern Forest Experiment Station for their contributions to the discussions of forest insects and diseases, and to Richard D. Lane, formerly chief of the Northeastern Station's Division of Forest Management Research (now Director of the Central States Forest Experiment Station), for preparing the section on reforestation of bituminous coal strippings. The survey data were summarized and the main body of this report was prepared by Earl H. Tryon of West Virginia University. William E. McQuilkin of the Northeastern Station assisted with technical editing.

The Silviculture Committee, during the period of the study, comprised the following: 1957-58 — John W. Andresen, William S. Corlett, Richard D. Lane, Albert G. Snow, Jr., Earl H. Tryon, and Walter W. Simonds, chairman. 1958-59 — John W. Andresen, Henry D. Gerhold, Richard D. Lane, George R. Moorhead, Craig D. Whitesell, and Earl H. Tryon, chairman. 1959-60 — Henry D. Gerhold, Richard D. Lane, George R. Moorhead, Craig D. Whitesell, and Earl H. Tryon, chairman.

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by

Silviculture Committee

Allegheny Section, Society of American Foresters

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INTRODUCTION

IN 1957 the Allegheny Section of the Society of American Foresters set up a Silviculture Committee to study forest planting practices in the Section's territory, which encompasses Delaware, Maryland, New Jersey, Pennsylvania, and West Virginia. This paper is a report of the Committee's findings.

Objectives of the study were to determine the practices being used in establishing forest plantations, and the variations in practices from one part of the territory to another, with respect to (1) species, (2) planting dates, (3) age of stock, (4) spacing, (5) design, (6) compatible cover, and (7) site preparation. The relationships of diseases, insects, and other damaging agents also were to be considered. The relationships of site factors, such as soil and topographic position, were not included.

Although the main concern in this survey of planting practices was with ordinary forest plantations, information on Christmas tree species and practices also is presented. A discussion of reforestation of bituminous coal-stripped lands is appended as a special supplement.

This paper is strictly an account of current practices and conditions as reported by foresters throughout the section; it does not offer recommendations.

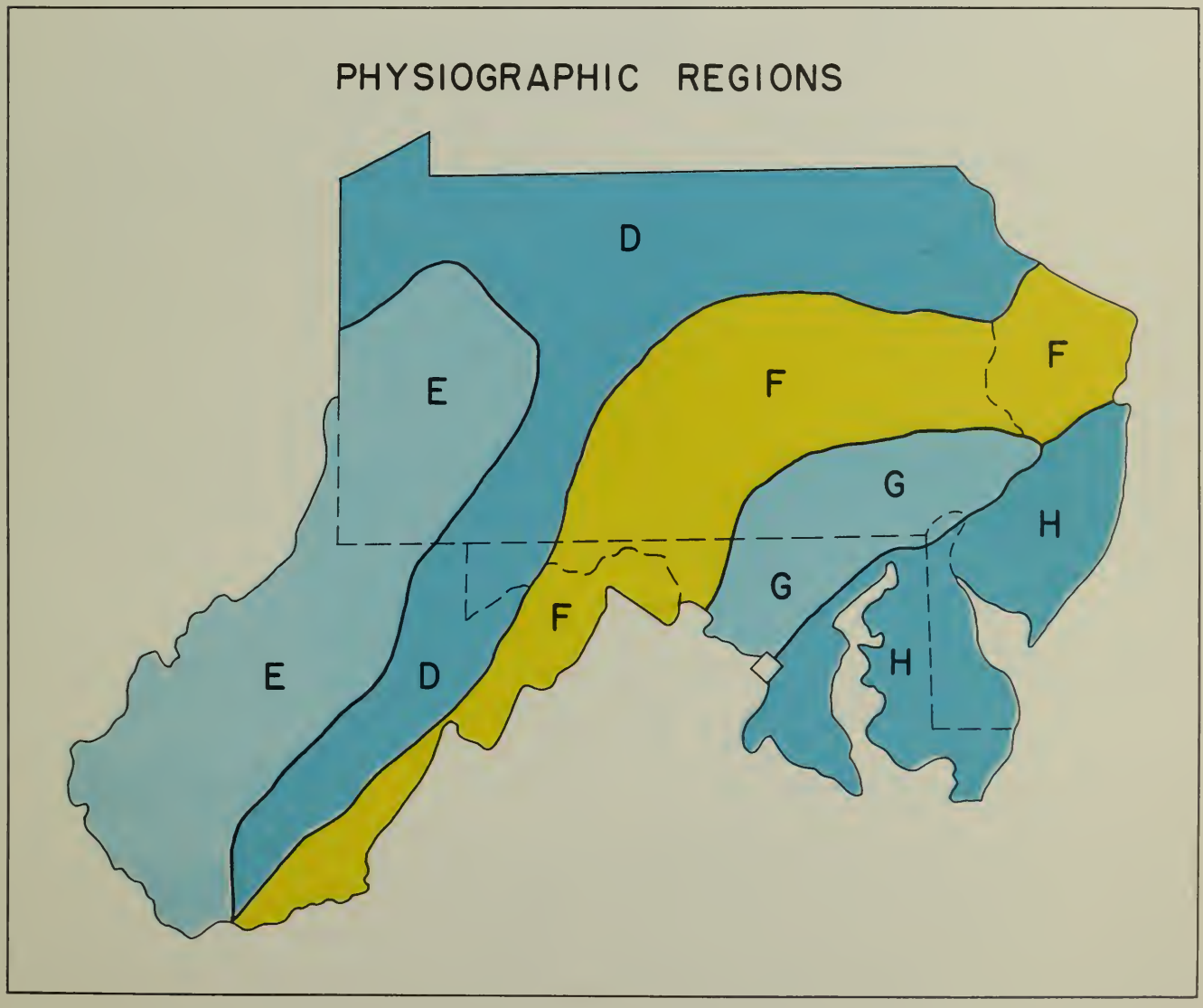

Figure 1.—The physiographic areas in the 5-state territory of the Allegheny Section.

Table 1.--Tree species planted in the 5-state territory of the Allegheny Section[1]

Common name	Technical name
SPECIES REPORTED IN SURVEY	
*Austrian pine	Pinus nigra Arnold
Eastern white pine	Pinus strobus L.
Jack pine	Pinus banksiana Lamb.
Japanese black pine	Pinus thunbergii Parl
Loblolly pine	Pinus taeda L.
Pitch pine	Pinus rigida Mill.
Red pine	Pinus resinosa Ait.
*Scotch pine	Pinus sylvestris L.
Shortleaf pine	Pinus echinata Mill.
Virginia pine	Pinus virginiana Mill.
*Blue spruce	Picea pungens Engelm.
*Norway spruce	Picea abies (L.) Karst.
*Red spruce	Picea rubens Sarg.
*White spruce	Picea glauca (Moench) Voss
*Douglas-fir	Pseudotsuga menziesii var. glauca (Beissn.) Franco var. caesia (Schwerin) Franco var. viridis (Schwerin) Franco
Eastern hemlock	Tsuga canadensis (L.) Carr.
Tamarack	Larix laricina (Du Roi) K. Koch
European larch	Larix decidua Mill.
Japanese larch	Larix leptolepis (Sieb. & Zucc) Gord.
Green ash	Fraxinus pennsylvanica Marsh
White ash	Fraxinus americana L.
Black cherry	Prunus serotina Ehrh.
Black locust	Robinia pseudoacacia L.
Northern red oak	Quercus rubra L.
Pin oak	Quercus palustris Muenchh.
White oak	Quercus alba L.
Black walnut	Juglans nigra L.
Yellow-poplar	Liriodendron tulipifera L.
OTHER SPECIES OCCASIONALLY PLANTED	
*Balsam fir	Abies balsamea (L.) Mill.
*Fraser fir	Abies fraseri (Pursh) Poir.
*White fir	Abies concolor (Gord. & Glend.) Lindl.
Southern catalpa	Catalpa bignonioides Walt.
Hybrid poplar	Populus x spp.
European alder	Alnus glutinosa (L.) Gaertn.
*Black hills spruce	Picea glauca var. densata Bailey

[1]Nomenclature mostly according to Little, Elbert L., Jr. Check list of native and naturalized trees of the United States (including Alaska). U.S. Dept. Agr., Agr. Hdbk. 41, 472 pp., 1953. A few exotics not listed by Little follow Rehder, Alfred. Manual of cultivated trees and shrubs. Ed. 2, 996 pp., New York, 1958.

*Mainly or entirely Christmas-tree species.

PROCEDURE

Climate, soils, and topography vary widely throughout the Allegheny Section territory. To obtain a reasonable degree of uniformity in sampling and in assembling data, the territory was divided into five areas (fig. 1). These areas are similar to those used by the Northeastern Forest Soils Conference. They are based on the major physiographic divisions recognized by the Soil Conservation Service in their work in land-resource analysis. Designation of the areas as D, E, F, G, and H is the same as that used by the Forest Soils Conference except that northern New Jersey has been included in Area F instead of in a different area extending down from the north. A description of each area with respect to climate, topography, geology, soils, and forest types is included in the report of the Forest Soils Conference Planting Site Committee, and will not be presented here.

The Allegheny Section Committee obtained pertinent data in 1957 and 1958 by means of a questionnaire that was distributed to a number of foresters familiar with planting programs and practices in the Section territory. Recipients of the questionnaire were so selected that each area of each state would be covered by a competent reporter. Responses to the questionnaire were summarized for each state (with Maryland and Delaware lumped) by local Committee members.

Each state summary was broken down by physiographic areas within the state. As shown in figure 1, the state boundaries (with Maryland and Delaware lumped) split the areas into 13 segments — 4 in Pennsylvania, 2 in New Jersey, 4 in Maryland-Delaware, and 3 in West Virginia. These segments of the physiographic areas are the basic geographic units used in reporting practices and conditions. The summaries for the 13 segments comprise the basic data for this report.

The study, a relatively simple survey, drew from the pooled experience of several foresters in each state and each area. Respondents reported planting practices and conditions by species. The data — mostly in the form of estimates — are based on occurrences, not on volume of stock planted. Thus, a large planting carried little or no more weight than a small one. The summarized results, derived as they are mostly from subjective estimates, make no claim to detailed accuracy, but are believed to give a reliable appraisal of the general situation for each item covered.

RESULTS

Species Planted

Twenty-eight species were reported on in the questionnaire as being planted in the Section territory (table 1). Nineteen species (68 percent) were conifers — 10 pines, 4 spruces, 3 larches — and 9 species (32 percent) were hardwoods. Also listed in table 1 are 7 additional species that are planted only to a limited extent, and consequently were not covered in the survey.

Of the 28 species, 20 are native to the East, 6 are from foreign countries, and 2 are from the western United States.

White pine, pitch pine, and Norway spruce were planted in all areas and in all states. Red pine, Scotch pine, white spruce, and Japanese larch were planted in all areas but not in all states. Loblolly and shortleaf pine were planted in four of the five areas (E, F, G, and H). Loblolly pine, formerly planted in all three states of Area H, is no longer used in New Jersey because of damage from the southern fusiform rust.

Black locust and yellow-poplar were reported as being by far the most commonly planted hardwoods in all areas and all states. Red oak and white ash, next in occurrence, ranked much lower. The greatest number of hardwood plantings were reported in Pennsylvania and West Virginia, and the lowest number in Maryland and Delaware.

Of the species used largely or solely for Christmas trees, Norway spruce and Scotch pine were by far the most commonly planted.

Planting Season

Spring planting was much more common in all parts of the territory than fall planting. A map of planting regions, based primarily on reported spring planting dates, is shown in figure 2. Spring planting dates are correlated in a general way with climate, as indicated by earlier starting and termination dates in the southern regions. However, the planting regions are not strictly climatic; they also reflect local forestry policies and cus-

toms. This is particularly evident when Regions I and II in New Jersey are compared with adjacent regions of similar climate: starting dates are later and termination dates are earlier in New Jersey because little planting is done in the state, and that in a comparatively short season.

A comparison of figures 1 and 2 shows some boundaries in common, but many that are different. The areas in figure 1 are based primarily upon physiographic features of the land, in some instances extend across a considerable range in climate, and are unrelated to man's activities; thus, it is to be expected that in many places the regional boundaries of figure 2 would differ.

Fall planting was reported as being done to a limited extent, but nearly always was second choice to spring planting. The greatest number of reports of fall planting came from Area F in Pennsylvania, closely followed by Area D in the same state. In Pennsylvania, most of the conifers and several hardwoods are fall-planted; in Area D of West Virginia black locust is also fall-planted as is loblolly pine in Area H of Maryland and Delaware.

In the warmer parts of Areas H and E (Regions III and VIII), planting has been done some years throughout the winter. In Region III, it is common practice to start planting loblolly pine in November and continue through the winter until the soil becomes too wet.

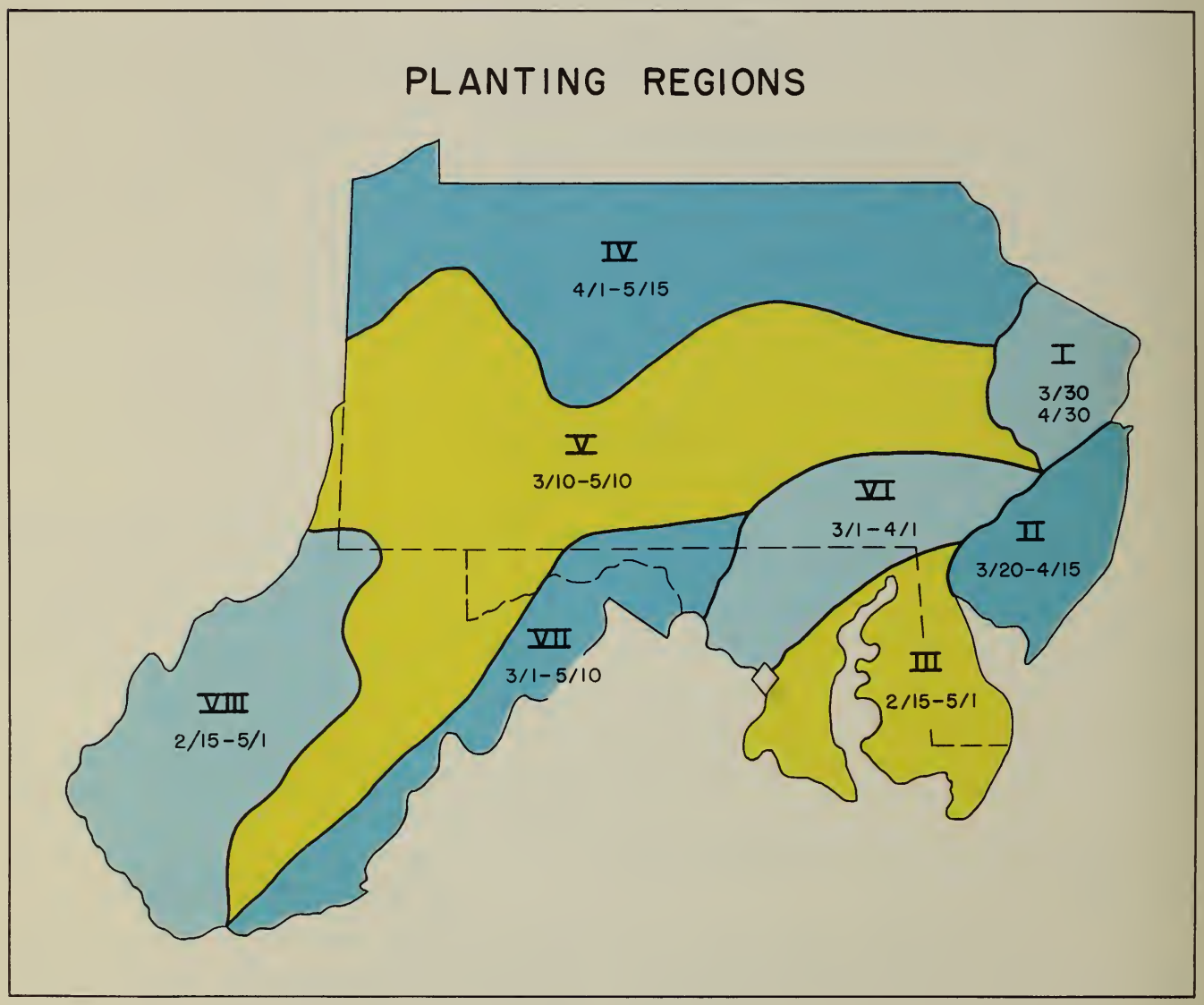

Figure 2. — Planting regions of the Allegheny Section territory, delineated according to the most commonly observed planting season (4/1 — 5/15 means from April 1 to May 15).

Table 2.--Age classes of stock most commonly planted, by species groups

(Basis: Percentage of reports for within-state physiographic areas)

Species group	Age of planting stock					
	1-0	2-0	3-0	4-0	2-1	3-2
Southern pines[1]	73	27	--	--	--	--
Other pines[2]	--	74	22	2	2	--
Spruces, Douglas-fir, and hemlock[3]	--	35	36	20	6	3
Larches[4]	35	55	10	--	--	--
Hardwoods[5]	97	3	--	--	--	--
All species	32	43	16	5	3	1

[1] Loblolly pine, shortleaf pine, Virginia pine. [2] Austrian pine, eastern white pine, jack pine, Japanese black pine, pitch pine. [3] Blue spruce, Norway spruce, red spruce, white spruce, Douglas-fir, eastern hemlock. [4] Tamarack, European larch, Japanese larch. [5] Green ash, white ash, black cherry, black locust, northern red oak, pin oak, white oak, black walnut, yellow-poplar.

In general, all species are planted during the same period within a given region, except European and Japanese larches. Because the larches break dormancy earlier than other species, larch planting is done mostly during the early part of the local planting season.

Age of Stock

The ages of stock most commonly planted were reported by species and by segments of the physiographic areas in each state (Maryland and Delaware lumped); these data are summarized in table 2 by species groups for the Section territory as a whole. In this table the base for the percentage figures for each group is the total number of reports by physiographic segments for all species in the group, and each individual figure represents the number of reports in which stock of the designated age was named as being the most commonly planted.[1] The main points brought out in table 2 are:

- Seedling stock predominates; only a small amount of transplant stock is used.
- For southern pines and for hardwoods, 1-0 stock is much more generally used than 2-0 stock.
- For "other pines" 2-0 stock is more generally used than that of any other age; 3-0 ranks second, being named as most commonly planted in 22 percent of the reports.
- For the larches also, 2-0 stock is more generally used than that of any other age, but unlike the pines, the second ranking age is 1-0.
- For the spruces, Douglas-fir, and hemlock, no one age class predominates, but 2-0 and 3-0 in about equal proportions definitely outrank all other ages. An added note, not shown in the table: Norway and white spruces are more often planted as 2-0 stock than the other species in this group.

From all states except New Jersey, reports on the more important species also included the ages of stock that ranked second in frequency of use. When these second-order rankings for the separate physiographic

[1] In further explanation of the derivation of the percentage figures in table 2, the southern pines group may be analyzed as an example: Four reports (representing 4 physiographic segments) were received for loblolly, 5 for shortleaf, and 6 for Virginia pine—a total of 15 reports. Of these, 11 reports (73 percent) named 1-0 as the age most commonly planted; 4 reports (27 percent) named 2-0 as most commonly planted. These are the percentage figures appearing in the table.

segments were summarized, they agreed in general with the ages shown in table 2 as ranking second among segments in most common use. Perhaps the most significant divergence in the two differently derived summaries relates to the use of transplant stock: only 3+ percent (rounded to 4 percent in table 2) of the reports named transplant stock as most commonly used, but 20 percent of them named transplants as second in frequency of use. Most of the transplants go into Christmas tree plantations.

Usage by age classes was fairly uniform for each species throughout its planting range. However, a few trends associated with geographic location were noted. One was a tendency toward use of older stock in the colder parts of the territory. In line with this tendency, 3-0 stock of the group comprising the spruces, Douglas-fir, and hemlock was more favored over 2-0 stock in Area D than elsewhere. The 2-0 age class of Norway and white spruces and the 1-0 class of larches were more favored over older stock in Maryland than in other states. In Pennsylvania, 3-0 stock of the "other pines" was more favored over 2-0 stock than in other states.

Spacing

Considerable variation in spacing was reported. Spacing ranged mostly from 4 x 4 feet for some Christmas tree plantings to 8 x 8 feet for some timber plantings. The widest spacing reported was 14 x 14 feet; this was for black walnut in Pennsylvania. Besides the usual practice of closer spacing for Christmas trees than other plantings, customary spacings vary among species and among states.

As for ages of stock, spacings were reported by species by segments of physiographic areas within each state. For all species collectively, 6 x 6 feet is the most commonly used spacing in timber plantations in the territory, being so named in half of the reports (table 3). Next in order was 6 x 7 feet, named in 18 percent of the reports, and 8 x 8, named in 17 percent of them. The 6 x 6 spacing is most common for all species groups except the larches, for which 8 x 8 was most commonly reported.

Spacing practices in plantations for timber vary markedly among the states (table 4), presumably as a result of differing policies and recommendations of the various state forestry departments. In New Jersey and West Virginia, 6 x 6 spacing is by far the most common practice. In New Jersey this is the most commonly used spacing for all species except the larches, some of which are planted at 8 x 8. In West Virginia, small proportions of the plantings of pines, Norway spruce, and European larch are put in at 6 x 7 and 7 x 7. The strong preference for 6 x 7 spacing shown in table 4 for the Maryland-Delaware unit applies mainly to Maryland; 6 x 6 is the more common practice in Delaware. Pennsylvania shows a stronger trend toward use of wider

Table 3.--Spacings most commonly used, by species groups

(Basis: Percentage of reports on each spacing)

Species group[1]	Mainly Christmas tree use		Mainly timber use				
	4x4	5x5	6x6	6x7	7x7	8x8	10x10 or wider
Southern pines	--	5	55	29	3	8	--
Other pines	5	5	54	19	1	16	--
Spruces, Douglas-fir, and hemlock	25	5	48	11	1	9	1
Larches	--	2	18	22	4	47	7
Hardwoods	1	--	68	14	2	10	5
All species	7	3	50	18	2	17	3

[1] See table 2 for species within each species-group.

Table 4.--Spacings most commonly used, by states

(Basis: Percentage of reports on each spacing)

State	Mainly Christmas tree use		Mainly timber use				
	4x4	5x5	6x6	6x7	7x7	8x8	10x10 or more
Maryland-Delaware	--	--	26	65	--	9	--
New Jersey	--	13	81	--	--	6	--
Pennsylvania	15	3	44	--	1	32	5
West Virginia	3	6	79	4	6	2	--

spacing, particularly 8 x 8, than any other state.[2] This spacing is used for practically all species. Some larch is planted at 10 x 10.

Most Christmas tree plantations, as indicated in tables 3 and 4, are spaced either 4 x 4 or 5 x 5 feet. Since many respondents reported only on forestry plantings, the percentage figures for Christmas trees in the tables indicate only roughly the distribution between 4 x 4 and 5 x 5 spacings, and the proportions of total planting for Christmas tree production. Although no data on Christmas tree spacing was included in the Maryland-Delaware reports, 5 x 5 spacing is known to be generally favored in Maryland and 4 x 4 in Delaware.

Design

The term *design,* as used here, refers to the alternatives of pure or single-species versus mixed-species plantings, including for the latter the pattern of the mixtures.

Of the individual species reports by segments of physiographic areas, 31 percent listed pure plantings as the usual practice, 54 percent listed pure as more common than mixed plantings, and 15 percent listed mixed plantings as the usual practice (table 5). Although the table shows considerable variation among species groups, the first two columns together definitely indicate that pure plantings predominate to some degree in all groups. The predominance of pure plantings is strongest in the southern pines; mixed plantings were reported most often for the group comprising the spruces, Douglas-fir, and hemlock.

The data on mixture patterns are rather weak, since almost half (42 percent) of the reports that mentioned mixtures did not specify the pattern. The 58 percent that did specify a pattern are divided as follows: by strips — 25 percent, by blocks—18 percent, by rows—15 percent.

Practices in the use of mixtures varied among states and, as with spacing, the differences undoubtedly reflect different policies of state forestry departments more than any relevant basic differences in planting conditions. In New Jersey, the strip pattern of mixing is the only pattern mentioned in the reports. In Maryland, most of the reports that specified a pattern specified mixtures by rows. In West Virginia, block mixtures are favored, with no reported use of strips. In Pennsylvania, all patterns were reported, with no one pattern in strong predominance; row mixtures were favored somewhat less than mixtures by blocks or strips.

Bucket mixtures were reported in a few instances from New Jersey and Pennsylvania.

In the row mixtures that are favored in Maryland, one of the species often is regarded as a filler, which presumably will make up no more than a minor part of the final crop. Some of the better filler trees may be harvested as Christmas trees; others may simply serve as trainers and die later or be removed in thinnings. Red and Scotch pines and white and Norway spruces are named as filler species in white pine plantations, and red pine

[2] According to J. E. Ibberson, Chief of Forest Advisory Services, Pennsylvania Department of Forests and Waters, most forestry agencies and individual foresters concerned with planting in the state usually recommend 8- x 8-foot spacing, except for plantings under the ACP program and plantings on strip-mine spoil banks.

Table 5.--Plantation design used, by species groups

(Basis: Percentage of reports naming each design)

Species group[1]	Plantation design		
	Pure	Pure and mixed, with pure more common	Mixed
Southern pines	71	23	6
Other pines	19	66	15
Spruces, Douglas-fir, and hemlock	20	52	28
Larches	16	79	5
Hardwoods	44	41	15
All species	31	54	15

[1]See table 2 for species within each species group.

is mentioned as a filler in larch plantations. This practice was not reported from any other state.

A small amount of underplanting was reported in Pennsylvania and West Virginia. Hemlock, Norway spruce, and red oak were mentioned as the species used in this manner. In general, underplanting is not a common practice in the territory.

Compatible Cover

This term refers to types of vegetation that may grow in association with planted trees without seriously interfering with their survival and growth. Responses to this item on the questionnaire were generalized and, almost certainly, the responses were more colored by personal opinions and biases than is true of the other items. Of necessity, compatible cover can be treated here only superficially.

The main types of cover considered were grass sod, annual plants, and light brush. The pines, spruces, Douglas-fir, and hemlock were generally reported to be compatible with sod and annual plants. In the Maryland-Delaware unit, loblolly and white pines and Norway and white spruces were cited as compatible with light brush. The larches, according to some Pennsylvania reports, are compatible with annual plants and with the thinner or more open types of sod.

Hardwoods generally were reported compatible with light brush, and somewhat compatible with annual plants. They were generally regarded as incompatible with sod.

By way of further comment, it should be recognized that compatability, as loosely used in this survey, includes both simple competitive relationships and relationships that involve other effects — detrimental or beneficial — of one species or group of species upon another. Simple competition perhaps is the more common type of incompatibility, and certainly it is the more easily interpreted. Provided the physical site is suitable, tree seedlings in most associations usually will live and make fair growth if they get enough light. It is true that, on dry sites or in dry years, competition for moisture may seriously limit growth in all associations, or even cause mortality. It is also true that some types of cover deplete soil moisture more than others, and that some tree species can withstand more adversity than others. But except for one broad class of associations—hardwood seedlings in grass sod — any adverse effects of cover upon tree seedlings seem mostly to be direct expressions of competition.

In the case of hardwoods in sod, however, there often appears to be a true incompatibility that involves something more than mere competition. Regardless of the availability of light and moisture, most of the young trees do not thrive. The cause of this reaction has not been thoroughly demonstrated. A commonly held hy-

pothesis, which is supported by a limited amount of experimental evidence, is that grass roots release some substance that is antagonistic or depressive to the hardwood tree roots.

Site Preparation

The procedures considered here are, for the most part, those applicable to old fields and pastures in which trees and brush either are absent or represent only a minor part of the plant cover.

Only a small part of the planting in the section territory is done in brushlands and cutover or burned forest lands. Site preparation for such plantings usually requires special equipment and methods, which were not covered in most of the reports. The principal methods listed for old fields and pastures are scalping, furrowing, disking, and prescribed-burning.

Practices differed considerably among states and somewhat among physiographic areas within states.

In Pennsylvania, furrowing was the most common method reported, and disking ranked second. Furrowing is almost universally practiced in Area G, and considerable furrowing or disking is done in Area F, largely in Christmas tree plantings. Much of the planting elsewhere in the state is done without site preparation.

Scalping is the most favored method in West Virginia, furrowing second. Furrowing is restricted almost entirely to Area F. Site preparation is more commonly practiced in both Areas E and F than in Area D.

The Maryland-Delaware reports indicate that site preparation is done for practically all planting in those states except on recently abandoned fields. Scalping, furrowing, and disking all are used, scalping most commonly. For Area H, bulldozing and prescribed-burning also are listed among site-preparation practices. These measures are applicable primarily to cutovers.

Less site preparation is done in New Jersey than in the other states, apparently because most of the planting is on newly abandoned fields. Prescribed-burning is the only practice listed for the state; this is recommended for plantings of pitch and shortleaf pines on cutovers and brushy abandoned lands.

DISEASES

Neither the respondents to the questionnaire nor the Committee members were well enough informed on plantation diseases to report authoritatively on them. Therefore, the survey-by-questionnaire procedure followed for previously discussed items was not used here. Instead, Robert W. Brandt, forest pathologist at the New Haven Laboratory of the Northeastern Forest Experiment Station, prepared a table showing the diseases known to be present and capable of attacking each of the planted species in the different segments of the physiographic areas. Brandt's compilation, with a few additions by the committee, appears in tables 6 and 7.

The listing of a disease in Brandt's table does not necessarily mean that it is causing a significant amount of damage in plantations; listing merely means presence and the potential for attack on the designated species. In general, diseases thus far have not caused a great deal of damage in plantations. However, with increasing acreage being devoted to tree planting under the Soil Bank and the various state conservation programs, plantation diseases very likely will become more destructive in the future.

The disease presently causing the greatest concern as a threat to plantations is the root- and butt-rot of conifers caused by *Fomes annosus*. This is a widely distributed fungus; damage caused by it has been reported from all states in the territory. Trees that are "off site" tend to suffer greater damage than those well adapted to their sites. However, the greatest threat from *F. annosus* develops, regardless of site adaptation, as plantations reach the age for thinning. When some trees are cut, the fungus infects the stumps, then spreads through the dead root systems and infects many of the reserved trees through root contacts. Infected trees are weakened, growth is reduced, and — particularly in pines — there may be considerable mortality. Also, trees weakened by root rot are more susceptible to blowdown.

Table 6.--Diseases present and capable of attacking plantation species in Allegheny Section territory

Common name	Scientific name	Symbol used in table 7
White pine blister rust	Cronartium ribicola	A
Diplodia twig blight	Diplodia pinea	B
Root rot	Cylindrocladium scoparium	C
Canker	Nectria galligena	D
Canker	Nectria magnoliae	E
Canker	Cytospora kunzei	F
Canker	Strumella coryneoidea	G
Canker	Atropellis tingens	H
Needle cast of spruce	--	I
Needle cast	Rhabdocline pseudotsugae	J
Needle cast	Hypoderma lethale	K
Needle cast	Lophodermium pinastri	L
Pine needle rust	Coleosporium asterum	M
Eastern gall rust	Cronartium cerebrum	N
Sweet fern rust	Cronartium comptoniae	O
Southern fusiform rust	Cronartium fusiforme	P
Brown spot needle blight	Scirrhia acicola	Q
Shot hole	Coccomyces lutescens	R
Sooty mold	Capnodium spp.	S
Black knot	Dibotryum morbosum	T
Eastern mistletoe	Phoradendron flavescens	U
Root rot	Phytophthora spp.	V
Fomes root rot	Fomes annosus	W
Canker	Fomes rimosus	X
Witches broom virus	--	Y
Tip blight	--	Z
Pine tip dieback	--	a

Table 7.--Plantation species used in Allegheny Section territory, and diseases* they are susceptible to, by state and area

Tree species	New Jersey		Pennsylvania				Maryland		Delaware		West Virginia		
	Area H	Area F	Area G	Area F	Area E	Area D	Area H	Area G	Area F	Area D	Area F	Area E	Area D
Austrian pine			BZ	B		BL	H	H	H	H			
Eastern white pine	W	AL	A	AL	AL	AKLW	C		A	A	A	AV	W
Jack pine	MOW					L							
Japanese black pine	OPW						MPQ						
Loblolly pine	P												
Pitch pine	CKSW	K	HS	HS		S	KOS	S					
Red pine	CMW	M	MC	MS		CMSL	CM	MWC	WC	W	M	V	
Scotch pine	CO	M		Ma	a	BM	C						
Shortleaf pine	OW												
Virginia pine	MO		MNO	NO		L	MNOSW	MNO	N				
Blue spruce			F	F	I	FI							
Norway spruce	CFW			FI	I	F	V						
Red spruce													
White spruce				FI	I	FI							
Douglas-fir	BW					J							
Eastern hemlock	C				FL	F							
Eastern larch						L							
European larch	W												
Japanese larch	C												
Green ash													
White ash													
Black cherry					DRT	DRT					DT	DT	DT
Black locust				XY	XY	XY						XY	
Northern red oak	U			G	G	G	U	U			G	G	G
Pin oak	U			G	G	G	U	U					
White oak					G	G							
Black walnut													
Yellow-poplar								E	E	E		E	CE

*For key to disease symbols, see table 6.

INSECTS

Insect pests of plantations were handled in much the same way as diseases, and for the same reason. In this instance William E. Waters, forest entomologist at the Northeastern Station's New Haven Laboratory, prepared a table of the insect pests known to be present and capable of attacking each of the planted tree species in the different segments of the physiographic areas. As with diseases, the listing of an insect merely means presence and the potential for damage — not that serious damage is a common occurrence. Water's tabulation appears in tables 8 and 9.

A comparison of tables 7 and 9 shows that there are many more potentially destructive insects than diseases.

Also, the damage currently being done by some of these insects appears to be much greater than that caused by diseases. Among the more destructive ones are the white-pine weevil, European pine shoot moth, Nantucket pine tip moth, pine sawflies, forest tent caterpillar, and locust borer.

Table 8.--Insects present and capable of attacking plantation species in Allegheny Section territory

Common name	Scientific name	Symbol used in table 9
Pine bark aphid	Pineus strobi	A
Twig aphids	Cinara spp. et al.	B
Spruce gall aphid	Chermes & Pineus spp.	C
Woolly larch aphid	Adelges laricobius	D
Oak scale	Asterolecanium spp.	E
Pine tortoise scale	Toumeyella numismaticum	F
Other scale	Phenacaspis spp. Lepidosaphes spp. et al.	G
Spittle bug	Aphrophora spp.	H
Ips engraver beetles	Ips spp.	I
Locust borer	Megacyllene robiniae	J
Locust leaf miner	Chalepus dorsalis	K
Locust twig borer	Ecdytolopha insiticiana	L
Pales weevil	Hylobius paks	M
White pine weevil	Pissodes strobi	N
Pine weevil	Pissodes approximatus P. nemorensis	O
Hemlock borer	Melanophila fulvoguttata	P
Japanese beetle	Popillia japonica	Q
European pine shoot moth	Rhyacionia buoliana	R
Nantucket pine tip moth	Rhyacionia frustrana	S
Pitch twig moth	Petrova spp.	T
Zimmerman pine moth	Dioryctria zimmermani	U
Pine webworm	Tetralopha robustella	V
Hemlock looper	Lambdina spp.	W
Larch casebearer	Coleophora laricella	X
Pine sawflies	Neodiprion spp.	Y
Larch sawfly	Pristiphora erichsoni	Z
Mites (red spiders)	Tetranychus spp., et al.	a
Forest tent caterpillar	Malacosoma distria	b
Allegheny mound ant	Formica exsectoides	c
Coneweevil	--	d
Gypsy moth	--	e
Bark borer	--	f
Scale--oyster shell	--	g
Bark beetle	--	h

Table 9.--Plantation species used in Allegheny Section territory, and insects* they are susceptible to, by state and area

Species	New Jersey		Pennsylvania			
	Area H	Area F	Area G	Area F	Area E	Area D
Austrian pine	FGIMRSTUVY	FGIMRSTUVY	FGIMRSTUVY	FGIMRSTUVY	FGIMRSTUVY	FGIMRSTUVY
Eastern white pine	GHIMORSTUVY	GHIMORSTUVY	GHIMORSTUVYd	GHIMORSTUVY	GHIMORSTUVYN	GHIMORSTUVYN
Jack pine				FHIMNTUVYZ	FHIMNTUVY	FHIMNTUVY
Japanese black pine	GHRTUY	GHRTUY	GHRTUY	GHRTUY	GHRTUY	GHRTUY
Loblolly pine						
Pitch pine	GHIMSTUVWY		GHIMSTUVWY	Z		SH
Red pine				Z		ZH
Scotch pine	FGHIMNORSTUVY	FGHIMNORSTUVY	FGHIMNORSTUVY	FGHIMNORSTUVY	FGHIMNORSTUVY	FGHIMNORSTUVY
Shortleaf pine	HIMOSTU					
Virginia pine	FGIMOSTUVY		FGIMOSTUVY	FGIMOSTUVY		
Blue spruce		CGa		CGa	CGa	CGaZN
Norway spruce		CGHMNa		CGHMNa	CGHMNaP	CGHMNa
Red spruce		CGMa		CGMa	CGMa	CGMa
White spruce		CGIMa		CGIMa	CGIMPa	CGIMNa
Douglas-fir					BCG	BCG
Eastern hemlock		PWaG		PWaG	PWaG	PWaGe
Eastern larch						DGXZe
European larch	QZ	QZ	QZ	XGZ	XG	DXGZ
Japanese larch	QG	QG	QG	ZGX	ZG	DZG
Green ash		G	G	Gg		
White ash		G	G	G		fZ
Black cherry			ZQ			
Black locust	GQ	GJK	GJK	GJK	GJK	GJK
Northern red oak		Ea		Ea		Ea
Pin oak		Ea		Ea		Ea
White oak		G	G	G		fZ
Black walnut	GQ		GQ			
Yellow-poplar				G	G	G

*For key to insects symbols, see table 8.

(continued)

Table 9.--Continued

Species	Maryland		Delaware		West Virginia		
	Area H	Area G	Area F	Area D	Area F	Area E	Area D
Austrian pine	FGIMRSTUVY	FGIMRSTUVY	FGIMRSTUVY	FGIMRSTUVY	FGIMRSTUVY	FGIMRSTUVY	FGIMRSTUVY
Eastern white pine	GHIMORSTU VYN	GHIMORSTU VYN	GHIMORSTU VYN	GHIMORSTU VYN	GHIMORSTU VY	GHIMORSTU VYc	GHIMORSTU VYc
Jack pine						FHIMNTUVY	FHIMNTUVY
Japanese black pine	GHRTUY	GHRTUY	GHRTUY	GHRTUY	GHRTUY	GHRTUY	GHRTUY
Loblolly pine	HIMRSTUZVh	SZYh					
Pitch pine	GHIMSTUVWY	GHIMSTUVWYZ	Z	Z		TY	TY
Red pine	S	ZY	ZV	ZVRM			
Scotch pine	FGHIMNORS TUVY	FGHIMNORS TUVYZ	FGHIMNORS TUVYZ	FGHIMNORS TUVYZ	FGHIMNORS TUVY	FGHIMNORS TUVY	FGHIMNORS TUVY
Shortleaf pine	HIMOSTU	SZ	SZ				
Virginia pine	FGIMOSTU VYhZ	FGIMOSTUV YZ	FGIMOSTU VYZ		FGIMOSTU VY	FGIMOSTUVY	FGIMOSTUVY
Blue spruce			CGa	CGa	CGa	CGa	CGa
Norway spruce			CGHMNa	CGHMNa	CGHMNa	CGHMNa	CGHMNa
Red spruce			CGMa	CGMa	CGMHa	CGMHa	CGMa
White spruce			CGIMa	CGIMa	CGIMa	CGIMa	CGIMa
Douglas-fir				BCG		BCG	BCG
Eastern hemlock			PWaG	PWaG	PWaG	PWaG	PWaG
Eastern larch				GXZ			
European larch	QG	QG	XG	QXG	XG	XG	XG
Japanese larch	QZ	QZ					
Green ash							
White ash							
Black cherry		ZQ					
Black locust	GJK	GJK	GJK	GJK	GJKL	GJKL	GJKL
Northern red oak			Ea	Ea	Ea	b	Ea
Pin oak			Ea	Ea	Ea		Ea
White oak							
Black walnut	GQ	GQ					
Yellow-poplar			G	G	G	G	G

OTHER DAMAGING AGENTS

Plantations may be damaged by various climatic events or conditions, and by various biotic agents other than insects and diseases. Information on such factors was not reported on the survey questionnaires. The following summary statements on other damaging factors were prepared by the Committee.

Spring frosts — Late spring frosts occurring after new growth has started can damage almost all species. Several hardwoods, the larches, spruces, and Douglas-fir seem to be more vulnerable than the pines. Frost damage has been observed in Pennsylvania, mainly on the larches, Douglas-fir, and spruces, and in West Virginia on European larch, Douglas-fir, yellow-poplar, and red oak. Christmas tree growers particularly should avoid frost pockets for Douglas-fir plantings.

Winter injury—This type of injury is believed usually to result from excessive drying of the tops while the roots are in frozen soil and incapable of supplying adequate moisture. Evergreen species generally are more susceptible than deciduous ones. Fall plantings that fail to make good root growth before the winter freeze-up are especially subject to winter injury and mortality. Winter injury has caused considerable concern among the growers of Douglas-fir Christmas trees in Pennsylvania. The blue variety from the Rocky Mountain Region seems to be somewhat more winter-hardy in the East than the Pacific Coast varieties.

Frost heaving — This type of damage is most likely to be serious during the first winter after planting. Although it can happen to any species, shallow-rooted species such as the spruces and firs are more often affected. Heaving occurs most commonly in fine-textured soils, and during periods when there is no snow cover.

Glaze—Heavy build-ups of wet snow and ice on trees may break branches and main stems, or so bend them that they are permanently deformed. Trees of sapling and small pole sizes are more subject to stem breakage or permanent deformity than smaller or larger sizes. Prevalence of glaze storms is correlated with regional climates and with altitude within climatic zones.

On the Allegheny Plateau in Pennsylvania, for instance, glaze storms are much more frequent above 2,000 feet elevation than at lower altitudes. Eastern West Virginia, western Maryland, northern and northwestern Pennsylvania, and northern New Jersey are somewhat more subject to glaze storms than other parts of the territory. No marked differences in susceptibility are apparent between the evergreen conifers and deciduous hardwoods; the larches, however, are somewhat more susceptible to damage than many other species. Although evergreens such as pine and spruce present more surface than deciduous trees for ice accumulation, this tends to be compensated for by greater stiffness of stems and greater capacity of branches to droop without breaking.

Deer browsing — In localities with a high deer population, plantations may be much damaged and even ruined by these animals. Although practically all of the commonly planted tree species may be browsed, some are fed upon much more than others. In general, spruces suffer relatively little damage, whereas pines — white pine especially — on the same site may be severely eaten back. Both hardwoods and conifers may be browsed; hardwoods are somewhat more likely to be taken in summer as well as in winter. Heavy deer damage occurs in western Maryland, northern West Virginia, and across all of northern Pennsylvania.

Rabbit clipping—Most rabbit damage occurs on hardwoods, very little on conifers. Rabbits undoubtedly have been a major factor in many hardwood plantation failures throughout the East. In West Virginia specifically, they have been largely responsible for frequent failures in attempts to establish red oak plantations.

Mouse girdling — Although mouse damage is much less than that done by deer and rabbits, mice occasionally may injure or kill a considerable number of trees in a plantation. Trees in the seedling to small sapling sizes are most subject to severe damage. Mice girdle the stems near the ground line or the larger roots near their juncture with the stem. Presence of heavy grass or other protective cover is an important factor in the buildup of destructive mouse populations. Mouse girdling has been specifically reported on Virginia and Scotch pines in Maryland, and on shortleaf pine, black locust, and red oak plantings in West Virginia.

Shovel-root, balled roots, U-roots — These and similar terms refer to the condition that ensues when a tree seedling's roots are jammed together and bent or doubled back upon themselves in planting. It is the result of careless or hasty planting by indifferent workmen — planting holes that are too shallow, planting slits that are imperfectly opened, or failure to manipulate the roots into a suspended position even though the slit be well opened. It is especially likely to occur in bar-slit

planting in heavy soils. Trees that are so planted may start and grow more or less normally for a decade or so. But in many of the more flagrant cases of root distortion, the tree is unable to produce an adequate root system and, as crowns grow larger and put increasing demands upon the root systems, vigor declines. This may be followed by mortality of standing trees, or by losses through blow-down.

APPENDIX

Reforestation of Bituminous Coal Strippings[3]

(A Supplemental Report on a Special Planting Problem)

Since the early 1940s there has been a striking increase in the strip or open-pit method of mining coal in the eastern bituminous fields. Open-pit mining is conducted in three states of the Allegheny Section — Maryland, Pennsylvania, and West Virginia. More than half of the counties in West Virginia have some stripping. In Pennsylvania, bituminous stripping occurs in Areas D, E, and F (fig. 1).

State laws in Pennsylvania and West Virginia require grading and revegetating of coal-stripped lands; in Maryland only grading is required. Some 10,000 acres of stripped land are now being planted each year in Pennsylvania; this is about half of the total annual planting in the state. In West Virginia about 2,000 acres become available for revegetation each year, most of which is planted or seeded to trees, although some acreage is seeded to forage plants. In Maryland, with its relatively small strip-mining industry and no legal requirement for revegetation, little reforestation planting is done — no more than 50 acres per year.

Strip-mine banks present unique conditions for tree planting. Among the bank characteristics that strongly influence planting success are:

Grading — Usually the grading required by state law is the only site preparation involved. Some investigators have found grading to be detrimental, others have found it to have little effect upon planted trees. Research in the Central States has shown that detrimental effects tend to be associated with high contents of calcareous clay in the bank material. Such clays become excessively compacted during grading operations.

Age of banks — The length of time since disturbance significantly affects natural plant cover on stripped lands. In West Virginia, natural cover generally increases with age up to about 3 years; subsequent changes occur at a distinctly slower rate.

Physical composition — To support tree growth, bank materials must include a substantial proportion of soil-size particles (2 mm. or smaller). Minimum content of such particles for successful planting is about 20 percent.

Acidity — A pH of 4.0 is the threshold for successful plantings.

Elevation—The limitations imposed by elevation upon selection of species for planting on undisturbed soils apply equally to stripped lands.

Slope—Planting becomes more difficult as slope steepness increases, and planted trees become more easily dislodged by erosion and slides of the bank material. Planting seldom is feasible on slopes steeper than 75 percent.

The same factors that were discussed in the main text in relation to planting on undisturbed lands are discussed below for stripped lands in the bituminous coal fields of the territory.

Species planted and age of stock — These two items are combined here in a single tabulation (table 10). The species used are mostly the same as those used in field planting, and the same age classes of stock predominate: 2-0 for conifers and 1-0 for hardwoods.

Planting season—In Pennsylvania about two-thirds of the planting is done in the spring and one-third in the fall. Spring planting dates are essentially the same as for undisturbed lands. Fall planting starts about September 5 and continues through October. All mine-bank planting in Maryland and West Virginia is done in the spring.

Spacing — In Pennsylvania 6 x 6 spacing is required by law; the same spacing is recommended in Maryland and West Virginia.

Design — Pure plantings have predominated in the past in both Pennsylvania and West Virginia, although

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[3] The Committee has drawn freely upon the following publications:
Hart, George E., and Byrnes, William R. PERFORMANCE OF TREES PLANTED ON COAL-STRIPPED LANDS IN THE BITUMINOUS REGION OF PENNSYLVANIA. Pa. State Forest School Res. Paper 28. 2 pp. 1959.
Lindstrom, G. A. FORESTATION OF STRIP-MINED LAND IN THE CENTRAL STATES. U.S. Dept. Agr., Agr. Hdbk. 166. 74 pp., illus. 1960.
Potter, H. Spencer, Weitzman, Sidney, and Trimble, George R., Jr. REFORESTATION OF STRIP-MINED LANDS IN WEST VIRGINIA. Northeast. Forest Expt. Sta., Sta. Paper 43. 28 pp., 1951.
Much information was also generously furnished by
H. Wheeler Wilson, Forester, Pa. Dept. of Mines and Mineral Industries.

some mixed plantings were reported. All future mine-bank planting in Pennsylvania will be mixed by strips, and mixed plantings now are recommended in West Virginia. Hardwood-conifer mixtures ordinarily are not recommended, especially not with black locust as the hardwood component. Conifer mixtures in blocks or strips, and black locust-other hardwood mixtures in 1 to 3 proportions, are recommended. For these hardwood mixtures, researchers in the Central States suggest planting alternate rows of the other hardwood pure with rows containing locust and the other hardwood in 50-50 random mixture.

Compatible cover — Since most mine-bank planting is on fresh or relatively young strippings where natural vegetation is sparse or absent, compatible cover seldom is a significant factor.

Site preparation — No site preparations other than the legally required grading were reported.

Table 10.--Species and ages of stock planted on bituminous strippings in the Allegheny Section territory

Species	Age of stock	Specific recommendations by states,[1] and other remarks
Red pine	2-0	W. Va. and Md.; not recommended in Pa.
White pine	2-0	All states.
Jack pine	2-0	Pa. and W. Va.; not reported from W. Va.
Austrian pine	2-0	Pa.; not reported from W. Va.
Scotch pine	2-0	Pa. and Md.
Virginia pine	2-0	Pa. and W. Va.
Pitch pine	2-0	Pa. and W. Va.; more commonly planted in Pa.
Shortleaf pine	2-0	Reported only from W. Va.
Norway spruce	2-0	Pa.
White spruce	2-0	Not reported from W. Va.; not recommended in Pa.
Japanese larch	1-0, 2-0	Pa.; 1-0 for spring, 2-0 for fall planting.
European larch	1-0, 2-0	1-0 for spring, 2-0 for fall planting. Not recommended in Pa.
Black locust	1-0	All states; direct seeding only in W. Va.
Red oak	1-0	Pa.
Ash	1-0	More commonly planted in Pa.
Yellow-poplar	1-0	W. Va.; reported from W. Va. only.
Black walnut	1-0	Reported from W. Va. only.
Chestnut oak	1-0	Reported from W. Va. only.
Catalpa	1-0	Reported from W. Va. only.

[1] Lack of a definite recommendation for or against a species in a state means either that not enough experience with the species on mine banks has been accumulated to substantiate a recommendation, or that the species' performance has been indecisive --neither markedly good nor markedly poor.